Vegetable Seed-Treatment In Western Washington

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VEGETABLE SEED-TREATMENT IN WESTERN WASHINGTON

Charles J. Gould[1]

Pea growers in western Washington apparently were the first to discover the value of seed treatment and to put it into practice. The treatment of pea seed was a more or less common practice by the time the first experimental proof of its benefit in this area was established by Schwartze (8)[2] in 1939. Following this work the treatment of pea seed was rapidly adopted by most other packers and large operators so that at the beginning of World War II a large percentage of such seed was being treated. Studies by Huber and Rundle (5), and Huber and Gould (6) had, meanwhile, demonstrated the value of seed treatment for certain other vegetables.

At the beginning of World War II it became evident that there might soon be a great need for extending the supplies of most vegetable seeds. It was also apparent that it would be desirable to know what materials could best be substituted for the copper and mercury compounds if they became "war casualties." Therefore, an expanded seed-treatment investigation was started at the Western Washington Experiment Station. The aims of the investigation were fourfold: (1) to determine which crops would benefit significantly from seed treatment; (2) to determine which available materials were most satisfactory for each crop, and which could be used, if necessary, as substitutes; (3) to determine the correct concentration of each material; and (4) to determine which, if any, materials could be applied in excess without harming the seed. The purpose of Point 4 was the potential benefit to the small-scale gardener who ordinarily does not use large amounts of seed and who seldom has equipment suitable for measuring required amounts of fungicides.

The data reported herein are the results of experiments conducted from 1942 to 1946, inclusive. Intermittent reports have been made as the work progressed. All the 1942 experiments, and certain ones in later years, were made in cooperation with the Seed Treatment Committee of the American Phytopathological Society and have been reported in the committee summaries published separately (9) or in the **Plant Disease Reporter** (10, 11). Other technical and popular reports are listed in the "Literature Cited" (1, 2, 3, 4).

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[2]Figures in parentheses ( ) refer to "Literature Cited" on page 45.

PROCEDURE

Materials. All the materials used on the seed of each crop are listed in the respective crop tables, as well as in the Summary Tables 18 to 21. Most of the common seed-treatment materials were used in the tests, the proprietary compounds being obtained through the courtesy of the respective manufacturers. A few other materials, such as phenothiazine and Dow DN-111, which for one reason or another were thought to have promise, were included in the tests.

Tersan, the wettable form of Arasan, was used in the 1942 and 1943 tests on cauliflower, and in the May 19, 1943, tests on spinach seed. However, only the name Arasan is used in the present writing in order to prevent confusion and to simplify tables.

Certain groups of compounds were found to give best results on particular types of seeds. In the hope of obtaining a mixture that could be used on all seeds, Arasan was mixed in equal amounts by weight with Spergon, Yellow Cuprocide, and Semesan, and the resulting mixtures were used in certain tests. Such mixtures generally did not prove any more satisfactory than the materials used alone, and in certain cases they were less satisfactory. Their results are omitted from discussion but the data are recorded in the tables.

Application. All materials when used as dusts were shaken with the seed for 3 to 5 minutes. In certain tests (designated "Maximum" in the tables) an excess of dust was applied, the seed shaken with it, and the residue screened off. This was essentially a test to determine which materials would be safest for the home gardener to use. Concentrations of materials used as dusts are represented in the tables as percentage of weight of seed. In 1943 some materials were applied in concentrations as high as 2 per cent by weight of seed. With certain types of large seeds, this was found to be excessive.

Certain compounds were also used in solutions or suspensions for treating seeds. The compounds used and the time intervals were as follows: Calomel for 5 minutes, copper sulfate for 1 hour, New Improved Ceresan for 5 minutes, and Semesan for 30 minutes (on carrot, celery and cucumber) or 1 hour (on lettuce, onion and spinach). Concentrations of these materials are represented in percentage of weight of solution.

Location. Most of the tests were conducted in various experiment station plots in the vicinity of Puyallup. Comparable tests were also made in 1944 at Mt. Vernon and Vancouver.

Seeding. In order to conserve on space, weeding time, etc., most seeding was heavier than that used commercially. The customary depth and time of planting for each locality was followed. Five replications of either 100 or 200 seeds were used in randomized blocks.

Data. Practically all the data secured are those of stand counts, taken when the plants were approximately 4 to 6 inches high and after it was fairly certain that emergence was complete. Yield data were obtained in addition to stand counts for peas.

EXPERIMENTAL RESULTS

In the next section a brief description is given of the results secured with the various crops. The crops are arranged alphabetically. The word "trial" as used in the description refers to each concentration of a material used in a significant test. Following this section are the tables of data for each crop, with pertinent notes. Materials are grouped in the tables according to the type of their active ingredients. Tables 18 to 21 summarize the most important data for different crops and materials.

BEANS

Seed treatment of beans was significantly beneficial in five of the eight tests run in different parts of western Washington from 1943 to 1946, inclusive. Increases in stand ranged from 13 to 59 per cent over the untreated sets. The three tests that failed to show beneficial results were all run in 1943 in soil that was too dry for proper germination.

BEANS

Untreated **Treated**

Materials which gave the best results in five or more trials were: Dow Seed Protectant 6-B, Semesan, and Spergon. Materials which appeared most promising in fewer than five trials were: Arasan, Dow Seed Protectant 5, and Phygon. Results of three tests in 1944 indicate that the manufacturers' recommended rate of 4 oz. of Arasan per 100 lbs. seed (balls) is probably too low for this area.

All materials tested at the maximum amount gave satisfactory results except Yellow Cuprocide. The others included Arasan, Phygon, Semesan, and Spergon.

The following materials gave reduced stands when the seeds were planted in dry soil: 2 per cent Ceresan (at 2 per cent), Yellow Cuprocide (0.2 per cent), AAZ Special (1.5 per cent), Dow Seed Protectant 6-B (1 per cent), and Dow DN-111 (1 per cent).

BEETS

Beet seed benefited significantly from treatment in seven out of eight tests over a 4-year period in different areas of western Washington. In the seven significant tests the stand of beets was increased by as much as 64 plants per 100 seed balls. The desirability of seed treatment is thus indicated. The only non-significant test occurred in relatively dry soil in 1943 at Puyallup.

Materials which gave the best results in five or more trials were: Arasan, 2 per cent Ceresan, and Dow Seed Protectant 6-B. Materials which appeared most promising in fewer than five trials were: AAZ Special, New Improved Ceresan, copper sulphate soak, and Phygon.

The following materials gave significant increases in stand when used at maximum concentrations: 2 per cent Ceresan, Arasan, and Phygon in one test.

Compounds that gave stands significantly lower than the untreated set in at least two trials were: 2 per cent Ceresan (0.5 per cent), Spergon (0.5 per cent) and Dow DN-111 (1 per cent).

CABBAGE

Earlier work by Huber and Gould (6) had demonstrated the benefit of cabbage seed treatment and the best materials for use by commercial growers. One question remained unanswered: Could the home gardener safely use the common materials in maximum amounts?

Only one of the two tests gave significant increases in stand over the untreated set. These increases were made with maximum amounts of Semesan, Arasan, and Spergon. Early emergence counts for the same test showed an inhibition of germination by Semesan, Yellow Cuprocide, and Phygon.

Cabbage and many other cruciferous crops show, in general, less benefit from seed treatment than do many other crops such as peas and spinach. Nevertheless, it seems advisable to treat seed of most cruciferous crops, especially if the seed is weak or old.

CARROTS

Although stands were increased by 8 to 17 per cent in the five tests with carrot seed, such increases were significant in only two tests.

There were no outstanding materials in these tests, but Arasan and Spergon were the best of those in five trials. Materials that appeared most promising in fewer than five trials were: Semesan, Red Cuprocide, and Phygon.

The following materials gave significant increases in one test when used at the maximum concentration: Arasan, Spergon, and Phygon. Dow DN-111 (at 1 per cent) was the only injurious material tested.

One of the Dow compounds was used in the April 9, 1946, test, but the number was not recorded. The data have consequently been omitted from the chart, although they were used in the analysis of variance.

CAULIFLOWER

Treatment of cauliflower seed was beneficial in all three tests made, but the results were not as spectacular as for such crops as peas and beets. However, the increases of 11 to 18 per cent were significant and would justify recommending treatment every year in western Washington.

Materials which gave the best results in five or more trials were Arasan, Fermate, and Spergon. Those materials which appeared most promising in fewer than five trials were: AAZ Special, Yellow Cuprocide, Semesan, Barbak C, and Calomel.

Calomel gave satisfactory results at the maximum concentration in two tests, and Arasan in one. None of the materials appeared to be injurious.

CELERY

Neither of the two tests run with celery seed in the greenhouse gave significant increases in stand, so the table of data is omitted. Ten different materials were used in these tests—some of them at several concentrations. The best increase in one test, 8.2 per cent, was obtained with Phenothiazine (at 1 per cent); and in the other test, 4.2 per cent with Semesan (at 0.2 per cent). It appears doubtful whether treatment of celery seed would be of much benefit to growers in western Washington.

CHARD, SWISS

The treatment of Swiss chard seed produced significant increases in stand in every one of the six tests run in different parts of western Washington. Increases in the number of plants emerging from 100 treated seed balls ranged from 32 to 123 more than from the same number of untreated seed balls.

Materials which gave the best results in five or more trials were: Arasan, 2 per cent Ceresan, New Improved Ceresan, and Fermate. Other materials that were most promising in fewer than five trials were: AAZ Special, copper sulfate soak, Red Cuprocide, Phygon, and Semesan.

Arasan, 2 per cent Ceresan, and Phygon gave significant increases in stands when used at the maximum concentration. The only apparent injury was in one test with the maximum concentration of Yellow Cuprocide.

CORN

Although corn significantly responded to seed treatment in seven of the eight tests, the increases of 6 to 17 per cent in stand counts were small, as compared with such crops as peas and beets. The greatest increases in stands were obtained in 1944 and 1945, using 200 seeds per replication and planting in soil with an optimum water content. Most of the tests which failed to show much benefit from treatment were planted in relatively dry soil.

CORN

Treated **Untreated**

Arasan was the only fungicide which gave much of an increase over the untreated set in five or more trials, and Phygon was the only one that showed much promise in a fewer number of trials. Both Arasan and Spergon increased stands at maximum concentrations in two or more trials, and Phygon and Semesan in one trial. Yellow Cuprocide was injurious in one test at the maximum concentration.

The materials that significantly reduced stands in these tests were: Dow

DN-111 (at 1 per cent in two tests), New Improved Semesan Jr. (0.3 per cent) in one test, Arasan (.08 and .17 per cent) in one test, and Yellow Cuprocide (maximum) in one test.

CUCUMBERS

Two of the four tests run with cucumber seed gave significant increases in stands of 62 and 66 per cent. The benefit from treatment of cucumber seed is sometimes obscured by the excessive post-emergence damping off that occurs with this crop. Seed treatment cannot prevent such post-emergence loss.

All materials used in the significant tests were beneficial in increasing stands, with the exception of Dow DN-111. The other materials were: 2 per cent Ceresan, Semesan, Semesan soak, Red Cuprocide, Yellow Cuprocide, Arasan, Fermate, Spergon, Phygon, AAZ Special, and Dow Seed Protectant 6-B. All of the following materials gave highly significant increases in stands when used at the maximum concentration: Semesan, Yellow Cuprocide, Arasan, Spergon, and Phygon.

KALE

Kale and celery seed benefited the least of any types of seed from treatment in these experiments. None of the three tests with kale seed gave significant increases in stands, although some slight benefit (3.5 to 11.6 per cent increase) was noted.

All of the following six materials used gave slightly increased stands over the untreated set: Semesan, Arasan, AAZ Special, Spergon, Dow Seed Protectant 5, and Dow Seed Protectant 6-B. The first three were used at the maximum concentration in addition to the usual concentration.

Since none of the tests were significant, the table of data is omitted.

LETTUCE

Although treatment increased the stand of lettuce an average of 22 per cent in eight tests, only three of these tests gave significant results. The eight tests were all field trials in different localities of western Washington, with the exception of one greenhouse trial in 1946.

All ten materials used in the two significant field tests increased stands significantly. The best materials used in five or more trials were: Arasan, 2 per cent Ceresan, Fermate, and Spergon. The ones most promising in a fewer number of tests were: AAZ Special, copper sulfate soak, Red Cuprocide, Yellow Cuprocide, Semesan, Phenothiazine, and Semesan soak.

Phygon was the only compound that appeared to be injurious. This occurred in one test at the maximum concentration. Arasan gave a highly significant increase in stand in one test when used at the maximum concentration.

LIMA BEANS

All four tests with lima bean seed gave significant increases in stand, ranging from 19 to 63 per cent. These results are comparable to those with other legumes, and indicate the need for seed treatment.

Fungicides which gave the best results in five or more trials were: Arasan, 2 per cent Ceresan, Fermate, and Spergon. Those fungicides which were most promising in fewer than five trials were: New Improved Ceresan, Dow Seed Protectant 6-B, and Semesan. None of these was used at the maximum concentration. The only injurious compound was Dow DN-111 at 0.3 per cent.

ONIONS

Treatment of onion seed significantly increased stand counts in only two of the six tests in different areas of western Washington. In one of these tests the percentage of increase was 13 and in the other test it was 21. In addition, there were only five times in these two tests when treatment was significantly beneficial. Arasan was responsible for this increase twice, and AAZ Special, Fermate, and Semesan once each.

None of the tests in which maximum amounts of fungicides were used gave significant increases, with the exception of one trial with Arasan. Dow DN-111 at 1.5 per cent in one test was injurious.

Unfortunately, the number of a Dow compound was not recorded in the April 9, 1946, test. The data have, therefore, been omitted from the table, but were included in the analysis of variance.

PEAS

This was one of the crops which responded most to seed treatment. Every one of the seventeen tests in different parts of western Washington gave statistically significant increases in stand. Increases in stand ranged from 6.5 to 84.6 per cent, with an average of 29 per cent. In these studies, which were carried on from 1942 into 1946, five different varieties were used. Data were obtained in 1942 and 1943 on pod and vine weights, in addition to stand counts.

All materials tested, except Dow DN-111, were generally effective in increasing the stand of peas significantly over the untreated set. Those materials which gave the best results in five or more trials were: Arasan, 2 per cent Ceresan, Yellow Cuprocide, Dow Seed Protectant 5, Dow Seed Protectant 6-B, Fermate, Phygon, Semesan, and Spergon. Other materials which were most promising in a fewer number of trials were: AAZ Special, New Improved Ceresan, and Red Cuprocide.

Several materials gave satisfactory results at the maximum concentration. They were: Arasan, Yellow Cuprocide, Phygon, Semesan, and Spergon. The only injurious compound was Dow DN-111 (at 1 per cent).

PEAS

Untreated **Treated**

That an increased stand does not necessarily insure an increased yield is indicated in the data for 1942. Both the yield of vines and of pods were taken from plots in which all compounds tested had produced stand counts significantly greater than the untreated set. Two varieties were used. With only one variety and two materials was the yield of vines plus pods significantly greater than the check. Similar results were obtained in another yield test in 1943. However, in these particular trials the stands from untreated seed were unusually high. This was apparently attributable to optimum growing conditions and strong germinating seed. Under less favorable conditions it would be expected and has been observed that seed treatment would definitely increase yields.

There were no appreciable differences between results obtained in various parts of western Washington, nor between early and late planting dates, with two exceptions. When the soil was quite wet at planting time (April 12 vs. May 24, 1944, tests) or the precipitation was high for 15 days after planting

(April 3 vs. June 1, 1945, tests) the stand was much poorer than under the drier conditions. The benefit from seed treatment is usually most evident under moist conditions.

Pea seed definitely should be treated before planting in western Washington, in view of the above results. Most of the common materials appeared to be effective, although certain ones usually gave slightly better results. Choice then becomes a matter of price, ease of handling, etc. In this connection it should also be remembered that certain materials, such as the mercury compounds, do not permit nitrogen-fixing bacteria to develop when applied to treated seed. With other materials, such as Spergon, enough of the bacteria survive to satisfactorily inoculate the plant roots under western Washington conditions.

RADISHES

The two tests with radish seed gave significant increases of 10 to 29 per cent in stand. In both cases the seeds were planted early in wet soil followed by heavy precipitation for the next 15 days.

All of the following materials gave highly significant increases in stand over the untreated set: Barbak C, Calomel, 2 per cent Ceresan, Semesan, Arasan, Fermate, and Spergon. AAZ Special was beneficial in one test and injurious in the other test at the same concentration. Yellow Cuprocide (at 0.75 per cent) was also injurious, whereas Red Cuprocide and Phenothiazine were ineffective.

SPINACH

Spinach was one of the vegetables that benefited most by seed treatment. Significant increases of 17 to 60 per cent in stand were obtained in thirteen of the sixteen tests. Results of treatments in 1944 in different parts of western Washington were comparable, as were the results between the early and late plantings, with the exception that better stands of both treated and untreated seed were obtained in the early planting. However, better results were obtained in 1945 in the late-planted set, due apparently in this case to excessive precipitation immediately following the early planting.

Almost all of the materials increased the stands of spinach. Of those given more than five trials in significant tests, Arasan, Yellow Cuprocide, 2 per cent Ceresan, Fermate, and Spergon were best. Of those tried a fewer number of times, Phygon, AAZ Special, Semesan, Semesan soak, Vasco 4, zinc oxide, and zinc hydroxide were best. Although Phygon was tried a fewer number of times than Spergon, it definitely appeared more promising as a treatment for spinach seed. Results of five of the six tests in 1944 comparing Arasan used at 0.25 per cent, and at maximum amounts, indicate that the manufacturers' recommended rate of 4 oz. per 100 lbs. seed is probably too low for this area. Likewise, four of the five tests in 1944 comparing Spergon at 1 per cent and maximum amounts indicate that the manufacturers' recommended rate of 14 oz. per 100 lbs. seed is probably low.

The following materials, used at the maximum concentrations, were significantly better than the untreated set in at least two trials: 2 per cent

Ceresan, Yellow Cuprocide, Arasan, Spergon, Dow Seed Protectant 5, and Phygon. Dow Seed Protectant 6-B, Dow DN-111, Red Cuprocide, and copper sulfate soak—at the concentrations used—were either ineffective or injurious in most trials.

SQUASH

The stand of squash was increased significantly over the untreated sets from 20 to 59 per cent in each of the five tests run in different areas of western Washington.

Materials giving the best results in five or more trials were: Yellow Cuprocide, Arasan, Phygon, Semesan, and Spergon. Dow Seed Protectant 5 was promising in fewer than five trials. All three trials with Yellow Cuprocide in 1944 indicated that the manufacturers' recommended rate of 3 oz. per 100 lbs. seed is probably too low for this area.

SQUASH

Untreated **Treated**

All of the following materials tested at the maximum concentrations were highly effective: Semesan, Yellow Cuprocide, Arasan, Phygon, and Spergon. Arasan (at 0.1 per cent) significantly reduced the stand in one test, but in three other tests it significantly increased stands over the untreated sets.

TOMATOES

Significant increases in stand of 28 to 43 per cent were obtained in all three tomato seed treatment tests. The results were comparable between two of the tests which were run in the greenhouse and one in the field.

Materials which gave the best results in more than five trials were: Arasan, 2 per cent Ceresan, Fermate, and Spergon. Those which were most promising in fewer than five trials were: New Improved Ceresan soak, AAZ Special, copper sulfate soak, and Yellow Cuprocide. None of the materia'ls were tried at maximum concentrations and none were injurious at the concentrations used.

TURNIPS

Significant increases in stand were obtained in two of the three tests with turnip seed. These increases were 22 per cent in a field test and 24 per cent in a greenhouse test, which are sufficient to indicate the desirability of seed treatment as a common practice.

None of the materials were used five times or more in significant tests. However, several of those used in fewer trials gave highly significant increased stands over the untreated set. They were: Phygon, Arasan, Fermate, Dow Seed Protectant 5, Semesan, and Spergon. The following materials gave significant increases in stand at maximum amounts: Arasan, Phygon, and Spergon.

Table 1. BEANS. Effect of Seed Treatments on Mean Stands.

Variety		Blue Lake		Blue Lake		Green Refugee	
Date planted		May 11		May 11		May 19	
Year planted		1943		1943		1943	
Location		Puyallup		Puyallup		Puyallup	
Field or greenhouse		Field No. 1		Field No. 2		Field	
Soil type		Sandy Loam		Silt Loam		Sandy Loam	
Number seeds per rep.		100		100		100	
Soil moisture		Dry		Dry		Dry	
Precipitation[1]		0.41		0.41		1.02	
	Dosage[2]	Stand	Dosage	Stand	Dosage	Stand
Untreated	-----	88.4	-----	75.6	-----	74.4
2% Ceresan	0.5	91.2	0.5	80.0		
2% Ceresan	1.0	87.0	1.0	67.8		
2% Ceresan	2.0	60.4†	2.0	55.0†		
New Imp. Ceresan	0.2	84.0	0.2	75.6		
Semesan	0.2	92.0	0.2	81.2		
Red Cuprocide	0.25	85.6	0.25	73.6		
Yellow Cuprocide	0.2	14.6†	0.2	2.4†		
Arasan	0.5	89.8	0.5	74.4	0.2	74.0
Arasan	1.0	89.6	1.0	83.8		
Arasan	2.0	90.4	2.0	84.2		
Fermate	0.5	85.0	0.5	72.8	0.2	74.0
Fermate	1.0	89.4	1.0	77.2		
Fermate	2.0	88.8	2.0	80.2		
Spergon	0.5	90.2	0.5	83.0	0.2	76.4
Spergon	1.0	89.8	1.0	77.2		
Spergon	2.0	87.2	2.0	77.4		
AAZ Special	1.5	83.0	1.5	63.0†		
DN-111	1.0	54.4†	1.0	46.4†		
Dow Seed Prot. No. 6-B	1.0	38.4†	1.0	60.4†		
"F" obtained		48.2		30.8		0.08
"F" needed (5%)		1.73		1.73		3.49
Least mean diff. (5%)		8.4		9.5		N.S.
Least mean diff. (1%)		11.2		12.6		

[1]Precipitation for fifteen days following planting.
[2]Per cent of weight of seed.
†Significantly lower than the untreated set at the 5% level.

Table 1. BEANS (Cont'd.)

Variety	Blue Lake	Blue Lake	Blue Lake	Blue Lake	Blue Lake
Date planted	May 18	May 16	May 24	June 1	February 13
Year planted	1944	1944	1944	1945	1946
Location	Vancouver	Puyallup	Mt. Vernon	Puyallup	Puyallup
Field or greenhouse	Field	Field	Field	Field	Greenhouse
Soil type	Silt Loam	Sandy Loam	Sandy Loam	Sandy Loam	Sandy Loam
Number of seeds per rep.	200	200	200	200	100
Soil moisture	Opt.	Opt.	Opt.	Opt.	Opt.
Precipitation	3.02	0.80	1.41	0.19	——

	Dosage	Stand	Dosage	Stand	Dosage	Stand	Dosage	Stand	Dosage	Stand
Untreated	-----	143.8	-----	50.4	-----	158.4	-----	159.4	-----	26.4
2% Ceresan	0.3	170.0**	0.3	48.4	0.3	181.0**				
Semesan	0.25	186.4**	0.25	108.8**	0.25	184.0**				
Semesan	Max.	184.6**	Max.	152.4**	Max.	183.0**	Max.	183.6**		
Yellow Cuprocide							Max.	125.4†		
Arasan	0.1	155.8	0.1	79.4*	0.1	178.0**	Max.	173.2*	Max.	85.0**
Arasan	Max.	156.6*	Max.	109.8**	Max.	183.6**				
Dow Seed Prot. No. 5	0.3	174.8**	0.3	104.0**	0.3	183.0**				
Phygon							Max.	184.4**	Max.	82.4**
Spergon	0.2	173.2**	0.2	92.8**	0.2	183.0**	Max.	185.0**	Max.	82.6**
Spergon	Max.	183.0**	Max.	129.8**	Max.	182.6**				
Dow Seed Prot. No. 6-B	0.3	161.2**	0.3	133.4**	0.3	171.8**				
Arasan & Semesan							Max.	172.6*		
Arasan & Spergon							Max.	175.0*	Max.	83.4**
Arasan & Yellow Cup.							Max.	176.2**		
Arasan & Sem. & Sper.							Max.	163.4		
"F" obtained		10.7		15.5		8.4		18.4		52.9
"F" needed (5%)		2.15		2.15		2.15		2.15		3.01
Least mean diff. (5%)		12.4		24.9		8.0		11.9		10.5
Least mean diff. (1%)		16.7		33.4		10.8		16.0		14.5

*Significantly better than the untreated set at the 5% level.
†Significantly lower than the untreated set at the 5% level.
**Significantly better than the untreated set at the 1% level.

Table 2. BEETS. Effect of Seed Treatments on Mean Stands.

Variety	Detroit Dark Red		Detroit Dark Red		Detroit Dark Red	
Date planted	May 11		May 11		May 19	
Year planted	1943		1943		1943	
Location	Puyallup		Puyallup		Puyallup	
Field or greenhouse	Field No. 1		Field No. 2		Field	
Soil type	Sandy Loam		Heavy Sandy Loam		Sandy Loam	
Precipitation	0.41		0.41		0.83	
Soil moisture	Opt.		Opt.		Dry	
Number of seed balls	100		100		100	
	Dosage	Stand	Dosage	Stand	Dosage	Stand
Untreated		76.0		74.0		94.4
2% Ceresan	0.5	54.4†	0.5	44.2†	0.5	110.2
2% Ceresan	1.0	85.2	1.0	132.8**	1.0	100.6
2% Ceresan	2.0	116.4**	2.0	138.4**	1.5	105.4
Semesan	1.25	95.8	1.25	116.2**		
Copper sulfate soak	2.0	88.0	2.0	117.0**		
Red Cuprocide	2.0	73.8	2.0	73.6		
Yellow Cuprocide	1.3	93.8	1.3	91.8	1.0	110.0
Yellow Cuprocide					2.0	91.4
Yellow Cuprocide					3.0	107.6
Arasan	0.5	48.0†	0.5	63.8	0.25	109.8
Arasan	1.0	77.2	1.0	119.0**	0.50	110.8
Arasan	2.0	100.2*	2.0	110.8**	1.0	105.4
Fermate	0.5	61.0	0.5	108.8**		
Fermate	1.0	83.4	1.0	107.6**		
Fermate	2.0	93.0	2.0	116.4**		
Spergon	0.5	22.4†	0.5	14.2†		
Spergon	1.0	69.6	1.0	64.6		
Spergon	2.0	61.4	2.0	79.8		
AAZ Special	2.0	82.0	2.0	94.8*		
DN-111	1.0	2.4†	1.0	6.0†		
Dow Seed Prot. No. 6-B	1.0	96.6	1.0	122.0**		
"F" obtained		13.43		34.01		0.69
"F" needed (5%)		1.73		1.73		2.15
Least mean diff. (5%)		20.8		17.9		N.S.
Least mean diff. (1%)		27.6		23.8		

*Significantly better than the untreated set at the 5% level.
†Significantly lower than the untreated set at the 5% level.
**Significantly better than the untreated set at the 1% level.

Table 2. BEETS (Cont'd.)

Variety	Detroit Dark Red		Detroit Dark Red		Detroit Dark Red		Detroit Dark Red		Detroit Dark Red	
Date planted	March 29		March 28		April 12		April 3		February 13	
Year planted	1944		1944		1944		1945		1946	
Location	Vancouver		Puyallup		Mt. Vernon		Puyallup		Puyallup	
Field or greenhouse	Field		Field		Field		Field		Greenhouse	
Soil type	Felida Silt Loam		Sandy Loam		Sandy Loam		Sandy Loam		Mixture	
Precipitation	1.67		1.39		2.91		2.47		-----	
Soil moisture	Opt.		Opt.		Wet		Opt.		Opt.	
Number of seed balls	200		200		200		200		100	
	Dosage	Stand	Dosage	Stand	Dosage	Stand	Dosage	Stand	Dosage	Stand
Untreated	-----	57.0**	-----	56.4	-----	141.0	-----	3.2	-----	8.6
2% Ceresan	1.0	137.6**	1.0	118.4**	1.0	182.4*				
2% Ceresan	Max.	104.0*	Max.	103.2**	Max.	197.8**				
New Improved Ceresan	0.2	123.0**	0.2	93.8*	0.2	183.8*				
Semesan							Max.	6.6		
Yellow Cuprocide	1.5	104.2*	1.5	98.4**	1.5	183.0*	Max.	2.4		
Yellow Cuprocide	Max.	81.8	Max.	48.8	Max.	114.2				
Arasan	0.5	137.6**	0.5	109.8**	0.5	218.4**	Max.	17.0**	Max.	42.2**
Arasan	Max.	151.0**	Max.	112.6**	Max.	207.2**				
Dow Seed Prot. No. 5	Max.	82.8	Max.	56.6	Max.	122.4				
Phygon							Max.	3.6	Max.	38.8**
Spergon							Max.	2.0	Max.	0.8
Dow Seed Prot. No. 6-B	1.5	110.6*	1.5	104.0**	1.5	178.8*				
Arasan & Semesan							Max.	22.0**		
Arasan & Spergon							Max.	9.6	Max.	11.2
Arasan & Yellow Cup.							Max.	10.4		
Arasan & Sem. & Sper.							Max.	12.2*		
"F" obtained		4.13		6.27		8.83		6.16		42.6
"F" needed (5%)		2.15		2.15		2.15		2.15		3.01
Least mean diff. (5%)		41.5		29.8		34.1		7.8		8.7
Least mean diff. (1%)		55.7		40.0		45.7		10.4		11.9

*Significantly better than the untreated set at the 5% level.
**Significantly better than the untreated set at the 1% level

Table 3. CABBAGE. Effect of Seed Treatments on Mean Stands.

Variety	Golden Acre		Golden Acre		Golden Acre	
Date planted	February 24		February 24		March 3	
Year planted	1945		1945		1946	
Location	Puyallup		Puyallup		Puyallup	
Field or greenhouse	Greenhouse No. 1		Greenhouse No. 2		Greenhouse	
Soil type	Mixture		Mixture		Mixture	
Soil moisture	Opt.		Opt.		Opt.	
Number of seeds	200		200		100	
	Dosage	Stand	Dosage	Stand	Dosage	Stand
		Early Emergence		Final Count		
Untreated	....	85.2	..	113.4	...	72.2
Semesan	Max.	57.6†	Max.	128.6*		
Yellow Cuprocide	Max.	63.2†	Max.	100.4		
Arasan	Max.	89.4	Max.	134.6**	Max.	78.8
Phygon	Max.	64.2†	Max.	117.6	Max.	75.4
Spergon	Max.	82.8	Max.	136.0**	Max.	78.4
Arasan & Semesan	Max.	80.8	Max.	135.6**		
Arasan & Spergon	Max.	85.8	Max.	136.0**	Max.	75.6
Arasan & Yellow Cuprocide	Max.	78.4	Max.	122.8		
Arasan & Sem. & Sper.	Max.	80.8	Max.	121.0		
"F" obtained		3.77		5.37		1.89
"F" needed (5%)		2.15		2.15		3.01
Least mean diff. (5%)		17.6		13.6		N.S.
Least mean diff. (1%)		23.6		18.3		

*Significantly better than the untreated set at the 5% level.
†Significantly lower than the untreated set at the 5% level.
**Significantly better than the untreated set at the 1% level.

Table 4. CARROTS. Effect of Seed Treatments on Mean Stands.

Variety	Imperator	Imperator	Chantenay	Imperator	Imperator
Date planted	May 7	May 4	April 1	April 3	April 9
Year planted	1943	1943	1944	1945	1946
Location	Puyallup	Puyallup	Puyallup	Puyallup	Puyallup
Field or greenhouse	Field No. 1	Field No. 2	Field	Field	Greenhouse
Soil type	Sandy Loam	Silt Loam	Sandy Loam	Sandy Loam	Mixture
Precipitation	0.50	0.55	2.47	2.47	----
Soil moisture	?	Wet	Dry	Opt.	Opt.
Number of seeds	100	100	100	200	100

	Dosage	Stand	Dosage	Stand	Dosage	Stand	Dosage	Stand	Dosage	Stand
Untreated	.....	37.4	...	34.0	...	1.6	...	33.4	...	51.8
2% Ceresan	0.5	32.8	0.5	41.8						
2% Ceresan	1.0	28.8	1.0	33.6						
2% Ceresan	2.0	28.6	2.0	37.0						
Semesan	0.4	30.8	0.4	30.6	0.42	11.6**	Max.	49.4		
Semesan soak	0.25	41.2	0.25	37.4						
Copper sulfate soak	2.0	37.8	2.0	38.4						
Red Cuprocide	1.5	37.8	1.5	31.2	1.0	6.8**				
Yellow Cuprocide	1.0	45.6	1.0	39.2			Max.	31.8		
Arasan	0.5	40.8	0.5	31.6	0.5	14.6**	Max.	55.8	Max.	62.2**
Arasan	1.0	37.2	1.0	40.8	0.75	7.0**				
Arasan	2.0	39.4	2.0	34.6						
Fermate	0.5	33.0	0.5	35.2						
Fermate	1.0	32.8	1.0	36.6						
Fermate	2.0	35.6	2.0	36.4						
Phygon							Max.	40.4	Max.	63.2**
Spergon	0.5	36.0	0.5	36.4	0.5	14.4**	Max.	41.6	Max.	69.0**
Spergon	1.0	39.0	1.0	39.8	0.75	3.2				
Spergon	2.0	33.4	2.0	35.6						
AAZ Special	2.0	40.6	2.0	38.0	1.0	2.8				
DN-111	1.0	18.0†	1.0	18.2						
Arasan & Semesan							Max.	38.4		
Arasan & Spergon							Max.	51.2	Max.	67.8**
Arasan & Yellow Cup.							Max.	51.0		
Arasan & Sem. & Sper.							Max.	43.6		
"F" obtained		3.12		1.03		26.0		2.03		66.1
"F" needed		1.73		1.73		2.36		2.15		2.71
Least mean diff. (5%)		9.5		N.S.		3.2		N.S.		7.2
Least mean diff. (1%)		12.7				4.3				9.8

†Significantly lower than the untreated set at the 5% level.
**Significantly better than the untreated set at the 1% level.

Table 5. CAULIFLOWER. Effect of Seed Treatments on Mean Stands.

Variety	Snowball	Snowball	Snowball
Date planted	March 4	March 4	April 2
Year planted	1943	1943	1946
Location	Puyallup	Puyallup	Puyallup
Field or greenhouse	Greenhouse No. 1	Greenhouse No. 2	Greenhouse
Soil type	Mixture	Mixture	Mixture
Soil moisture	Opt.	Opt.	Opt.
Number of seeds	100	100	100

	Dosage	Stand	Dosage	Stand	Dosage	Stand
Untreated	----	76.0	--	71.2	-----	18.8
Barbak C	2.0	82.4*	2.0	78.2		
Calomel	Max.	84.4**	Max.	86.6**		
2% Cerasan	0.25	83.6*	0.25	78.0		
2% Cerasan	0.75	78.4	0.75	80.0*		
2% Cerasan	1.5	82.0	1.5	80.8*		
Semesan	0.4	85.2**	0.4	85.8**		
Yellow Cuprocide	0.75	81.2	0.75	79.0*		
Metrox	1.0	78.2	1.0	68.0		
Arasan	0.25	82.0	0.25	89.6**	Max.	28.6**
Arasan	0.75	86.6**	0.75	89.6**		
Arasan	1.5	85.4**	1.5	87.8**		
Fermate	0.25	86.8**	0.25	84.4**		
Fermate	0.75	82.4*	0.75	86.0**		
Fermate	1.5	75.4	1.5	83.6**		
Phygon					Max.	20.4
Spergon	0.25	86.4**	0.25	84.8**	Max.	21.6
Spergon	0.75	85.6**	0.75	84.8**		
Spergon	1.5	85.8**	1.5	85.0**		
AAZ Special	2.0	83.8*	2.0	82.2**		
Arasan & Spergon					Max.	31.0**
Phenothiazine	1.0	75.8	1.0	75.2		
"F" obtained		35.2		4.85		10.0
"F" needed (5%)		1.73		1.73		3.0
Least mean diff. (5%)		6.2		7.4		5.1
Least mean diff. (1%)		8.2		9.8		7.0

*Significantly better than the untreated set at the 5% level.
**Significantly better than the untreated set at the 1% level.

Table 6. CHARD. Effect of Seed Treatments on Mean Stands.

Variety	Lucullus		Lucullus		Lucullus		Lucullus		Lucullus		Lucullus	
Date planted	April 24		April 17		March 30		March 28		April 12		January 14	
Year planted	1943		1943		1944		1944		1944		1946	
Location	Puyallup		Puyallup		Vancouver		Puyallup		Mt. Vernon		Puyallup	
Field or greenhouse	Field No. 1		Field No. 2		Field		Field		Field		Greenhouse	
Soil type	Sandy Loam		Silt Loam		Silt Loam		Sandy Loam		Sandy Loam		Mixture	
Precipitation	0.86		1.85		1.70		1.39		2.91		----	
Soil moisture	Wet		Wet		Opt.		Opt.		Wet		Opt.	
Number of seed balls	100		100		200		200		200		100	
	Dosage	Stand	Dosage	Stand	Dosage	Stand	Dosage	Stand	Dosage	Stand	Dosage	Stand
Untreated	----	20.8	----	9.2	----	190.0	----	115.2	----	221.4	----	27.8
2% Ceresan	0.5	101.2**	0.5	37.4**	0.5	253.2**	0.5	150.4*	0.5	293.4**		
2% Ceresan	1.0	98.0**	1.0	42.4**	Max.	286.4**	Max.	179.6**	Max.	261.6		
2% Ceresan	2.0	101.2**	2.0	61.6**								
New Imp. Ceresan	0.1	106.6**	0.1	51.4**	0.2	242.6**	0.2	147.0	0.2	241.4		
Semesan	0.4	74.6**	0.4	26.4**								
Copper sulfate soak	2.0	62.2**	2.0	21.0								
Red Cuprocide	1.0	46.8**	1.0	21.2								
Yellow Cuprocide	0.75	84.2**	0.75	38.4**	1.0	248.2**	1.0	148.6	1.0	241.0		
Yellow Cuprocide					Max.	168.6	Max.	118.6	Max.	169.6†		
Arasan	0.5	88.0**	0.5	37.6**	0.25	220.2	0.25	139.0	0.25	250.2	Max.	100.2**
Arasan	1.0	85.8**	1.0	41.8**	Max.	259.8**	Max.	158.2*	Max.	286.2**		
Arasan	2.0	97.8**	2.0	53.4**								
Fermate	0.5	64.6**	0.5	34.4**								
Fermate	1.0	81.0**	1.0	40.4**								
Fermate	2.0	83.4**	2.0	26.2**								
Dow Seed Prot. No. 5					Max.	210.6	Max.	144.2	Max.	231.0		
Phygon											Max.	150.4**
Spergon	0.5	33.2	0.5	9.0							Max.	45.6
Spergon	1.0	53.4**	1.0	18.0								
Spergon	2.0	51.8**	2.0	14.8								
AAZ Special	2.0	57.6**	2.0	23.6*								
Arasan & Spergon											Max.	109.2**
DN-111	1.0	5.2	1.0	0.6								
Dow Seed Prot. No. 6-B					Max.	163.4	Max.	135.8	Max.	211.2		
"F" obtained	16.9		13.3		13.7		2.45		6.51		66.7	
"F" needed (5%)	1.73		1.73		2.15		2.15		2.15		3.01	
Least mean diff. (5%)	19.4		12.5		31.7		34.0		40.6		18.3	
Least mean diff. (1%)	25.8		16.5		42.5		45.7		54.5		25.2	

*Significantly better than the untreated set at the 5% level.
†Significantly lower than the untreated set at the 5% level.
**Significantly better than the untreated set at the 1% level.

Table 7. CORN. Effect of Seed Treatments on Mean Stands.

Variety	Golden Cross Bantam		Golden Cross Bantam		Golden Cross Bantam		Golden Cross Bantam	
Date planted	May 17		May 18		May 18		May 27	
Year planted	1942		1943		1943		1943	
Location	Puyallup		Puyallup		Puyallup		Puyallup	
Field or greenhouse	Field		Field No. 1		Field No. 2		Field	
Soil type	Sandy Loam		Sandy Loam		Sandy Loam		Sandy Loam	
Precipitation	0.79		0.80		0.80		0.53	
Soil moisture	Opt.		Dry		Dry		Dry	
Number of seeds	100		100		100		100	
	Dosage	Stand	Dosage	Stand	Dosage	Stand	Dosage	Stand
Untreated	..	77.6	..	56.0	..	73.8	..	80.8
2% Ceresan			0.5	45.6	0.5	78.0		
2% Ceresan			1.0	51.8	1.0	76.8		
2% Ceresan			2.0	43.6	2.0	73.2		
Semesan			0.2	52.0	0.2	77.0		
Barbak C			0.3	44.2	0.3	78.4		
New Imp. Sem. Jr.			0.3	41.6	0.3	61.4†		
Semesan Jr.	0.17	83.8					0.17	80.8
Red Cuprocide	0.25	74.8	0.25	46.2	0.25	72.2		
Yellow Cuprocide			0.2	43.0	0.2	68.4		
Arasan			0.5	55.8	0.5	77.8	0.08	66.8†
Arasan			1.0	49.4	1.0	77.6	0.17	71.4†
Arasan			2.0	46.4	2.0	76.6	0.33	77.0
Fermate			0.5	61.0	0.5	80.2		
Fermate			1.0	62.0	1.0	77.6		
Fermate			2.0	53.0	2.0	76.4		
Spergon			0.5	62.6	0.5	82.4*	0.08	82.0
Spergon			1.0	49.6	1.0	79.4	0.17	86.4
Spergon			2.0	47.6	2.0	74.6	0.33	83.6
AAZ Special	2.0	80.8	1.5	43.8	1.5	71.6		
DN-111			1.0	37.2†	1.0	51.6†		
"F" obtained		2.65		1.84		8.93		4.11
"F" needed (5%)		3.49		1.73		1.73		2.36
Least mean diff. (5%)		N.S.		14.7		6.6		9.4
Least mean diff. (1%)				19.6		8.8		12.6

*Significantly better than the untreated set at the 5% level.
†Significantly lower than the untreated set at the 5% level.

Table 7. CORN (Cont'd.)

Variety	Golden Cross Bantam		Golden Cross Bantam		Golden Cross Bantam		Golden Cross Bantam	
Date planted	May 18		May 15		May 24		June 1	
Year planted	1944		1944		1944		1945	
Location	Vancouver		Puyallup		Mt. Vernon		Puyallup	
Field or greenhouse	Field		Field		Field		Field	
Soil type	Silt Loam		Sandy Loam		Sandy Loam		Sandy Loam	
Precipitation	3.02		0.75		1.41		0.19	
Soil moisture	Opt.		Opt.		Opt.		Opt.	
Number of seeds	200		200		200		200	
	Dosage	Stand	Dosage	Stand	Dosage	Stand	Dosage	Stand
Untreated		140.2		99.8		143.2		104.4
Semesan							Max.	123.0**
Barbak C	0.3	138.2	0.3	101.6	0.3	143.2		
Semesan Jr.	0.2	141.8	0.2	114.0	0.2	148.2		
Semesan Jr.	Max.	145.2	Max.	113.6	Max.	149.6		
Yellow Cuprocide							Max.	84.2†
Arasan	0.125	155.2**	0.125	125.6**	0.125	156.8**	Max.	121.8*
Arasan	Max.	153.2**	Max.	120.4**	Max.	161.2**		
Dow Seed Prot. No. 5	0.3	146.0	0.3	115.6*	0.3	149.8		
Phygon	0.2	143.2	0.2	133.8**	0.2	147.6	Max.	123.0**
Spergon	0.2	149.4*	0.2	113.6	0.2	149.0	Max.	118.4*
Spergon	Max.	146.8	Max.	119.2*	Max.	144.6		
Arasan & Semesan							Max.	111.8
Arasan & Spergon							Max.	121.2*
Arasan & Yellow Cup.							Max.	105.4
Arasan & Sem. & Sper.							Max.	116.8
"F" obtained	4.44		3.74		4.17		6.55	
"F" needed (5%)	2.15		2.15		2.15		2.15	
Least mean diff. (5%)	7.4		15.0		8.1		13.7	
Least mean diff. (1%)	10.0		20.2		10.9		18.4	

*Significantly better than the untreated set at the 5% level.
†Significantly lower than the untreated set at the 5% level.
**Significantly better than the untreated set at the 1% level.

Table 8. CUCUMBERS. Effect of Seed Treatments on Mean Stands.

Variety	Straight Eight		Straight Eight		"A and C"		Long Green	
Date planted	May 26		May 26		May 16		June 1	
Year planted	1943		1943		1944		1945	
Location	Puyallup		Puyallup		Puyallup		Puyallup	
Field or greenhouse	Field No. 1		Field No. 2		Field		Field	
Soil type	Sandy Loam		Sandy Loam		Sandy Loam		Sandy Loam	
Precipitation	0.53		0.53		0.80		0.19	
Soil moisture	Dry		Dry		Opt.		Opt.	
Number of seeds	100		100		100		200	
	Dosage	Stand	Dosage	Stand	Dosage	Stand	Dosage	Stand
Untreated	---	4.6	---	19.2	---	3.4	---	31.4
2% Ceresan	0.5	9.2	0.5	76.8**				
2% Ceresan	1.0	14.0	1.0	85.4**				
2% Ceresan	2.0	7.4	2.0	74.6**				
New Improved Ceresan					0.3	6.0		
Semesan	0.3	9.8	0.3	75.6**	0.3	5.6	Max.	81.0**
Semesan soak	0.25	9.8	0.25	74.4**				
Red Cuprocide	0.25	9.2	0.25	66.8**				
Yellow Cuprocide	0.2	9.8	0.2	74.4**	1.0	9.2	Max.	72.4**
Arasan	0.5	13.4	0.5	78.6**	0.3	8.6	Max.	80.2**
Arasan	1.0	13.6	1.0	69.0**				
Arasan	2.0	12.0	2.0	76.8**				
Fermate	0.5	12.2	0.5	75.8**				
Fermate	1.0	8.6	1.0	74.0**				
Fermate	2.0	13.8	2.0	75.2**				
Spergon	0.5	8.4	0.5	74.6**	0.3	9.4	Max.	69.6**
Spergon	1.0	11.6	1.0	70.4**				
Spergon	2.0	5.6	2.0	62.0**				
Phygon							Max.	93.4**
AAZ Special	1.5	4.4	1.5	70.2**				
DN-111	0.3	7.8	0.3	19.6				
Dow Seed Prot. No. 6-B	0.5	15.4	0.5	74.0**				
Arasan & Semesan							Max.	73.8**
Arasan & Spergon							Max.	83.2**
Arasan & Yellow Cup.							Max.	84.2**
Arasan & Sem. & Sper.							Max.	73.0**
"F" obtained		0.78		7.29		1.75		4.1
"F" needed (5%)		1.73		1.73		2.71		2.15
Least mean diff. (5%)		N.S.		18.2		N.S.		23.6
Least mean diff. (1%)				24.1				31.6

**Significantly better than the untreated set at the 1% level.

Table 9. LETTUCE. Effect of Seed Treatments on Mean Stands.

Variety		N.Y. No. 12		N.Y. No. 12		N.Y. No. 12	
Date planted		May 17		April 9		April 9	
Year planted		1942		1943		1943	
Location		Puyallup		Puyallup		Puyallup	
Field or greenhouse		Field		Field No. 1		Field No. 2	
Soil type		Sandy Loam		Silt Loam		Sandy Loam	
Precipitation		0.79		1.35		1.35	
Soil moisture		Opt.		Opt.		?	
Number of seeds		100		100		100	
	Dosage	Stand	Dosage	Stand	Dosage	Stand
Untreated	---	27.4	-----	20.0	-----	37.6
2% Ceresan			0.25	70.2**	0.25	71.0**
2% Ceresan			0.75	62.2**	0.75	65.2**
2% Ceresan			1.5	67.2**	1.5	62.6**
Semesan	0.2	27.6	0.2	68.0**	0.2	58.2**
Semesan soak			0.25	69.8**	0.25	73.6**
Copper sulfate soak			1.5	44.6**	1.5	57.6**
Red Cuprocide	2.0	34.6	2.0	75.8**	2.0	78.2**
Yellow Cuprocide			1.5	73.4**	1.5	73.8**
Arasan			0.25	63.2**	0.25	72.4**
Arasan			0.75	72.0**	0.75	71.0**
Arasan			1.5	66.2**	1.5	81.8**
Fermate			0.25	60.8**	0.25	68.2**
Fermate			0.75	49.0**	0.75	64.0**
Fermate			1.5	55.2**	1.5	69.4**
Spergon			0.25	61.4**	0.25	78.6**
Spergon			0.75	66.6**	0.75	68.2**
Spergon			1.5	78.0**	1.5	77.0**
AAZ Special	2.0	35.4	2.0	68.8**	2.0	68.0**
Phenethiazine			1.0	34.0**	1.0	42.0
"F" obtained		.867		15.7		10.1
"F" needed (5%)		3.49		1.73		1.73
Least mean diff. (5%)		N.S.		10.3		10.0
Least mean diff. (1%)				13.7		13.3

**Significantly better than the untreated set at the 1% level.

Table 9. LETTUCE (Cont'd.)

Variety	N.Y. No. 12		N.Y. No. 12		N.Y. No. 12		Grand Rapid		?	
Date planted	March 29		March 28		April 12		April 3		April 2	
Year planted	1944		1944		1944		1945		1946	
Location	Vancouver		Puyallup		Mt. Vernon		Puyallup		Puyallup	
Field or greenhouse	Field		Field		Field		Field		Greenhouse	
Soil type	Silt Loam		Sandy Loam		Sandy Loam		Sandy Loam		Mixture	
Precipitation	1.67		1.39		2.91		2.47		-----	
Soil moisture	Opt.		Opt.		Wet		Opt.		Opt.	
Number of seeds	200		200		200		200		100	
	Dosage	Stand	Dosage	Stand	Dosage	Stand	Dosage	Stand	Dosage	Stand
Untreated	----	88.4	----	71.8	----	69.0	----	19.0	----	19.8
Semesan	0.2	130.4	0.2	111.8	0.2	89.8	Max.	19.0		
Yellow Cuprocide	1.5	120.4	1.5	110.6	1.5	100.0	Max.	17.4		
Yellow Cuprocide	Max.	125.0	Max.	103.2	Max.	88.6				
Arasan	Max.	116.2	Max.	99.4	Max.	88.4	Max.	23.8	Max.	25.6**
Dow Seed Prot. No. 5	Max.	125.4	Max.	107.2	Max.	81.0				
Phygon							Max.	14.2	Max.	11.8†
Spergon	1.5	129.4	1.5	115.2	1.5	81.8	Max.	22.4	Max.	19.2
Spergon	Max.	123.8	Max.	107.6	Max.	81.0				
AAZ Special	2.0	116.6	2.0	102.4	2.0	81.6				
AAZ Special	Max.	124.2	Max.	98.8	Max.	92.0				
Arasan & Semesan							Max.	16.8		
Arasan & Spergon							Max.	15.2	Max.	21.2
Arasan & Yellow Cup.							Max.	20.8		
Arasan & Sem. & Sper.							Max.	17.2		
"F" obtained		1.95		2.00		0.71		0.96	13.4	
"F" needed (5%)		2.15		2.15		2.15		2.15	3.01	
Least mean diff. (5%)		N.S.		N.S.		N.S.		N.S.	4.1	
Least mean diff. (1%)									5.6	

†Significantly lower than the untreated set at the 5% level.
**Significantly better than the untreated set at the 1% level.

Table 10. LIMA BEANS. Effect of Seed Treatments on Mean Stands.

Variety	Henderson Bush		Henderson Bush		Henderson Bush		Henderson Bush	
Date Planted	May 17		May 27		May 27		May 27	
Year planted	1942		1943		1943		1943	
Location	Puyallup		Puyallup		Puyallup		Puyallup	
Field or greenhouse	Field		Field No. 1		Field No. 2		Field	
Precipitation	0.79		0.53		0.53		0.53	
Soil type	Sandy Loam		Sandy Loam		Silt Loam		Sandy Loam	
Soil moisture	Opt.		Opt.		Opt.		Opt.	
Number of seeds	100		100		100		100	
	Dosage	Stand	Dosage	Stand	Dosage	Stand	Dosage	Stand
Untreated	----	29.0	----	27.6	----	23.2	----	40.4
2% Ceresan			0.5	57.2**	0.5	71.6**		
2% Ceresan			1.0	56.4**	1.0	66.2**		
2% Ceresan			2.0	31.0	2.0	19.2		
New Imp. Ceresan			0.1	44.2**	0.1	54.8**		
Semesan			0.1	44.2**	0.1	48.8**		
Red Cuprocide			0.5	38.4	0 5	37.8		
Yellow Cuprocide			0.5	20.4	0.5	22.4		
Arasan	0.125	47.6*	0.5	43.8**	0.5	68.4**		
Arasan			1.0	51.6**	1.0	71.6**		
Arasan			2.0	43.6**	2.0	63.4**		
Fermate			0.5	44.6**	0.5	63.6**	0.1	52.6
Fermate			1.0	50.8**	1.0	69.0**	0.2	60.8**
Fermate			2.0	46.0**	2.0	78.0**		
Spergon	0.2	44.4*	0.5	55.0**	0.5	72.2**	0.1	68.0**
Spergon			1.0	50.0**	1.0	69.8**	0.2	71.6**
Spergon			2.0	43.6**	2.0	67.8**		
AAZ Special			1.5	34.4	1.5	36.0		
DN-111			0.3	—0.2	0.3	—0.4		
Dow Seed Prot. No. 6-B			0.5	51.8**	0.5	85.8**		
"F" obtained	4.68		11.2		15.5		7.94	
"F" needed (5%)	4.46		1.73		1.73		3.01	
Least mean diff. (5%)	15.0		11.6		16.7		13.3	
Least mean diff. (1%)	21.8		15.4		22.2		18.4	

*Significantly better than the untreated set at the 5% level.
**Significantly better than the untreated set at the 1% level.

Table 11. ONIONS. Effect of Seed Treatments on Mean Stands.

Variety	Select Oregon Yellow Danvers		Select Oregon Yellow Danvers		Yellow Globe Danvers		Yellow Globe Danvers		Yellow Globe Danvers		Yellow Globe Danvers	
Date planted	April 13		April 13		March 30		March 28		April 12		April 9	
Year planted	1943		1943		1944		1944		1944		1946	
Location	Puyallup		Puyallup		Vancouver		Puyallup		Mt. Vernon		Puyallup	
Field or greenhouse	Field No. 1		Field No. 2		Field		Field		Field		Greenhouse	
Soil type	Silt Loam		Sandy Loam		Silt Loam		Sandy Loam		Sandy Loam		Mixture	
Precipitation	1.85		1.85		1.70		1.39		2.91		-----	
Soil moisture	Opt.		Opt.		Opt.		Opt.		Wet		Opt.	
Number of seeds	100		100		200		200		200		100	
	Dosage	Stand	Dosage	Stand	Dosage	Stand	Dosage	Stand	Dosage	Stand	Dosage	Stand
Untreated	----	42.0	----	65.8	----	52.4	----	86.2	----	75.0	----	69.0
Calomel soak	1.0	44.2	1.0	73.4								
2% Cerasan	0.5	39.4	0.5	72.2								
2% Cerasan	1.0	42.2	1.0	70.8								
2% Cerasan	2.0	46.6	2.0	66.2								
Semesan	0.3	52.6	0.3	63.8	0.25	61.8	0.25	108.6*	0.25	79.4		
Semesan					Max.	73.0	Max.	105.6	Max.	83.4		
Semesan soak	0.25	52.8	0.25	73.0								
Red Cuprocide	1.0	44.0	1.0	64.4								
Yellow Cuprocide	0.75	50.4	0.75	66.8	1.0	51.8	1.0	102.2	1.0	79.4		
Arasan	0.5	52.4	0.5	68.4	0.25	74.0	0.25	105.2	0.25	88.4	Max.	69.6
Arasan	1.0	45.4	1.0	60.4	Max.	78.0	Max.	128.8**	Max.	90.8		
Arasan	2.0	48.8	2.0	78.0*								
Fermate	0.5	55.0	0.5	78.6*								
Fermate	1.0	43.2	1.0	70.2								
Fermate	2.0	42.4	2.0	70.8								
Dow Seed Prot. No. 5					Max.	70.8	Max.	93.4	Max.	70.6		
Phygon											Max.	74.2
Spergon	0.5	48.8	0.5	66.8	0.5	63.0	0.5	97.0	0.5	86.2	Max.	69.6
Spergon	1.0	39.2	1.0	66.0	Max.	69.2	Max.	105.4	Max.	79.6		
Spergon	2.0	46.0	2.0	75.6								
AAZ Special	1.5	56.2	1.5	66.2	2.0	59.0	2.0	112.6*	2.0	75.8		
Arasan & Spergon											Max.	69.2
DN-111	1.5	18.2	1.5	20.2†								
"F" obtained	1.70		11.7		1.43		2.59		0.79		1.15	
"F" needed (5%)	1.73		1.73		2.15		2.15		2.15		2.71	
Least mean diff. (5%)	N.S.		9.9		N.S.		20.5		N.S		N.S.	
Least mean diff. (1%)			13.1				27.6					

*Significantly better than the untreated set at the 5% level.
†Significantly lower than the untreated set at the 5% level.
**Significantly better than the untreated set at the 1% level.

Table 12. PEAS. Effect of Seed Treatments on Mean Stands.

Variety			Surprise				Alderman	
Date planted			March 16				March 16	
Year planted			1942				1942	
Location			Puyallup				Puyallup	
Field or greenhouse			Field				Field	
Soil type			Sandy Loam				Sandy Loam	
Precipitation			0.65				0.65	
Soil moisture			Opt.				Opt.	
Number of seeds			100				100	
	Dosage	Stand	Vine and Pod Yield	Pod Yield	Dosage	Stand	Vine and Pod Yield	Pod Yield
Untreated	.....	73.2	4896.0[3]	1175.8[3]	.....	73.6	8554.0[3]	2484.8[3]
Semesan	0.25	85.8**	5509.4	1476.8**	0.25	89.4**	9286.8	2683.8
Red Cuprocide	0.25	85.0**	5060.8	1301.0	0.25	89.4**	10076.4**	3308.8
Yellow Cuprocide	0.15	84.4**	4595.2	1215.4	0.15	91.4**	9278.2	2820.2
Spergon	0.2	81.2**	5413.0	1476.8**	0.2	93.2**	10232.6**	3010.6
"F" obtained		11.1	3.21	5.92		22.0	6.45	1.80
"F" needed (5%)		3.01	3.01	3.01		3.01	3.01	3.01
Least mean diff. (5%)		4.7	628.2	175.3		5.0	804.5	N.S.
Least mean diff. (1%)		6.4	865.5	241.6		6.9	108.5	

**Significantly better than the untreated set at the 1% level.
[3]Yield in grams.

Table 12. PEAS. (Cont'd.)

Variety	Thomas Laxton		Thomas Laxton		Thomas Laxton		Thomas Laxton		Thomas Laxton	
Date planted	April 5		April 5		April 3		June 1		January 14	
Year planted	1944		1944		1945		1945		1946	
Location	Puyallup		Puyallup		Puyallup		Puyallup		Puyallup	
Field or greenhouse	Field		Field		Field		Field		Greenhouse	
Soil type	Sandy Loam		Sandy Loam		Sandy Loam		Sandy Loam		Mixture	
Precipitation	2.55		2.55		2.47		0.19		----	
Soil moisture	Opt.		Opt.		Opt.		Opt.		Opt.	
Number of seeds	100		200		200		200		100	
	Dosage	Stand	Dosage	Stand	Dosage	Stand	Dosage	Stand	Dosage	Stand
Untreated	..	55.8	..	99.4	..	1.0	.. ..	73.0	..	6.2
Semesan					Max.	37.8**	Max.	122.8**		
Yellow Cuprocide					Max.	6.8	Max.	102.0**		
Arasan					Max.	30.8**	Max.	112.0**	Max.	39.0**
Dow Seed Prot. No. 5	0.25	76.0**	0.25	149.8**						
Dow Seed Prot. No. 5	0.12	75.2**	0.12	128.0*						
Phygon	0.25	77.0**	0.25	145.4**	Max.	77.8**	Max.	126.2**	Max.	90.8**
Spergon	0.25	67.6**	0.25	147.4**	Max.	84.8**	Max.	117.8**	Max.	81.8**
Arasan & Semesan					Max.	36.8**	Max.	122.2**		
Arasan & Spergon					Max.	64.2**	Max.	128.6**	Max.	47.4**
Arasan & Yellow Cup.					Max.	51.8**	Max.	113.8**		
Arasan & Sem. & Sper.					Max.	56.2**	Max.	121.6**		
"F" obtained		10.0		5.86		19.2		6.7		101.5
"F" needed (5%)		3.01		3.01		2.15		2.15		3.01
Least mean diff. (5%)		8.05		26.2		18.1		18.1		10.2
Least mean diff. (1%)		11.6		36.1		24.3		24.3		14.0

*Significantly better than the untreated set at the 5% level.
**Significantly better than the untreated set at the 1% level.

Table 12. PEAS (Cont'd.)

Variety	Thomas Laxton		Improved Telephone	Improved Telephone				Gradus	
Date planted	April 24		May 4	May 4				Fall	
Year planted	1943		1943	1943				1943	
Location	Puyallup		Puyallup	Puyallup				Puyallup	
Field or greenhouse	Field		Field	Field				Field	
Soil type	Sandy Loam		Sandy Loam	Silt Loam				Sandy Loam	
Precipitation	0.86		0.55	0.55				-----	
Soil moisture	Opt.		Opt.	Opt.				-----	
Number of seeds	100		100	100				200	
	Dosage	Stand	Pod Yield	Dosage	Stand	Dosage	Stand	Dosage	Stand
Untreated		73.2	1410.6[3]	...	51.6	.. ..	64.4		0.4
2% Ceresan				0.5	75.4**	0.5	82.4**	1.5	1.6
2% Ceresan				1.0	77.8**	1.0	86.2**		
2% Ceresan				2.0	87.0**	2.0	88.0**		
New Imp. Ceresan				0.2	73.0**	0.2	75.0*		
Semesan				0.3	82.8**	0.3	81.8**	0.3	6.4**
Red Cuprocide				0.25	66.8**	0.25	75.4**		
Yellow Cuprocide				0.17	77.0**	0.17	76.0**		
Arasan	0.084	75.8	1548.0	0.5	75.2**	0.5	82.0**	0.2	8.2**
Arasan	0.168	77.6	1515.2	1.0	75.2**	1.0	85.4**		
Arasan	0.355	78.8	1373.6	2.0	82.0**	2.0	79.8**		
Fermate	0.084	75.0	1461.4	0.5	73.4**	0.5	75.4**		
Fermate	0.168	77.2	1684.0	1.0	68.4**	1.0	83.0**		
Fermate	0.335	72.4	1743.6	2.0	72.4**	2.0	78.6**		
Spergon	0.084	78.2	1543.8	0.5	83.8**	0.5	82.2**	0.5	41.6**
Spergon	0.168	85.2**	1592.0	1.0	78.0**	1.0	85.6**		
Spergon	0.335	83.2**	1727.8	2.0	77.2**	2.0	86.4**		
AAZ Special				1.5	66.6**	1.5	70.2		
Dow Seed Prot. No. 6-B				1.0	36.6†	1.0†	44.8†	0.1	0.4
Dow Seed Prot. No. 6-B								0.5	1.2
DN-111				1.0	80.6**	1.0	83.2**	0.1	0.6
"F" obtained		2.51	0.55	9.86		11.9		101.1	
"F" needed (5%)		2.15	2.15	1.73		1.73		2.36	
Least mean diff. (5%)		7.3	N.S.	10.3		8.0		4.1	
Least mean diff. (1%)		9.8		13.7		10.7		5.5	

*Significantly better than the untreated set at the 5% level.
†Significantly lower than the untreated set at the 5% level.
**Significantly better than the untreated set at the 1% level.
[3]Yield in grams.

Table 12. PEAS (Cont'd.)

Variety	Thomas Laxton		Thomas Laxton		Thomas Laxton		Thomas Laxton		Thomas Laxton		Thomas Laxton	
Date planted	March 29		March 28		April 12		May 18		May 15		May 24	
Year planted	1944		1944		1944		1944		1944		1944	
Location	Vancouver		Puyallup		Mt. Vernon		Vancouver		Puyallup		Mt. Vernon	
Field or greenhouse	Field		Field		Field		Field		Field		Field	
Soil type	Silt Loam		Sandy Loam		Sandy Loam		Silt Loam		Sandy Loam		Sandy Loam	
Precipitation	1.67		1.39		2.91		3.02		0.75		1.41	
Soil moisture	Opt.		Opt.		Wet		Opt.		Opt.		Opt.	
Number of seeds	200		200		200		200		200		200	
	Dosage	Stand	Dosage	Stand	Dosage	Stand	Dosage	Stand	Dosage	Stand	Dosage	Stand
Untreated	---	114.0	---	90.6	---	125.4	---	132.8	---	65.6	---	170.8
Semesan	0.1	175.6**	0.1	149.8**	0.1	150.2**	0.1	171.0**	0.1	140.2**	0.1	178.8*
Semesan	Max.	177.8**	Max.	168.0**	Max.	166.2**	Max.	180.4**	Max.	157.6**	Max.	182.8**
Yellow Cuprocide	0.2	166.4**	0.2	151.8**	0.2	144.2**	0.2	174.2**	0.2	146.0**	0.2	174.2
Yellow Cuprocide	Max.	167.8**	Max.	154.6**	Max.	150.8**	Max.	169.8**	Max.	146.8**	Max.	171.8
Arasan	0.12	150.2**	0.12	121.4**	0.12	154.0**	0.12	140.6	0.12	98.0**	0.12	180.2**
Dow Seed Prot. No. 5	0.4	165.0**	0.4	152.2**	0.4	159.8**	0.4	163.0**	0.4	140.2**	0.4	180.8**
Spergon	0.25	166.2**	0.25	155.4**	0.25	164.8**	0.25	164.0**	0.25	125.8**	0.25	180.2**
Spergon	Max.	167.0**	Max.	163.2**	Max.	166.2**	Max.	176.4**	Max.	147.6**	Max.	183.8**
Dow Seed Prot. No. 6-B	0.4	168.6**	0.4	163.6**	0.4	156.8**	0.4	155.6**	0.4	116.0**	0.4	170.4
"F" obtained	32.1		50.7		13.4		15.5		41.0		4.62	
"F" needed (5%)	2.15		2.15		2.15		2.15		2.15		2.15	
Least mean diff. (5%)	9.3		9.5		9.7		11.3		12.6		6.8	
Least mean diff. (1%)	12.4		12.7		13.1		15.2		17.0		9.1	

*Significantly better than the untreated set at the 5% level.
**Significantly better than the untreated set at the 1% level.

Table 13. RADISHES. Effect of Seed Treatments on Mean Stands.

Variety	Early Scarlet Globe		Early Scarlet Globe	
Date planted	March 15		March 16	
Year planted	1943		1943	
Location	Puyallup		Puyallup	
Field or greenhouse	Field No. 1		Field No 2	
Soil type	Sandy Loam		Silt Loam	
Precipitation	3.62		3.87	
Soil moisture	Wet		Very Wet	
Number of seeds	100		100	
	Dosage	Stand	Dosage	Stand
Untreated	------	66.0	------	83.8
Barbak C	2.0	77.0**	2.0	90.2**
Calomel	Max.	84.2**	Max.	89.4*
2% Ceresan	0.25	92.2**	0.25	92.0**
2% Ceresan	0.75	90.6**	0.75	92.6**
2% Ceresan	1.5	91.4**	1.5	90.8**
Semesan	0.4	89.0**	0.4	93.8**
Red Cuprocide	1.0	65.4	1.0	85.2
Yellow Cuprocide	0.75	0.0†	0.75	8.0†
Arasan	0.25	87.8**	0.25	94.0**
Arasan	0.75	92.2**	0.75	91.2**
Arasan	1.5	94.6**	1.5	90.2**
Fermate	0.25	92.0**	0.25	93.6**
Fermate	0.75	82.2**	0.75	92.2**
Fermate	1.5	91.8**	1.5	90.4**
Spergon	0.25	86.8**	0.25	89.8*
Spergon	0.75	89.6**	0.75	90.8**
Spergon	1.5	86.0**	1.5	89.8*
AAZ Special	2.0	79.8**	2.0	76.6†
Phenothiazine	1.0	59.4	1.0	86.4
"F" obtained		70.9		131.4
"F" needed (5%)		1.73		1.73
Least mean diff. (5%)		7.1		4.6
Least mean diff. (1%)		9.5		6.1

*Significantly better than the untreated set at the 5% level.
†Significantly lower than the untreated set at the 5% level.
**Significantly better than the untreated set at the 1% level.

Variety	Virginia Savoy		Improved Thickleaf		Improved Thickleaf		Virginia Savoy		Nobel	
Date planted	May 17		April 17		April 17		May 19		Fall	
Year planted	1942		1943		1943		1943		1943	
Location	Puyallup		Puyallup		Puyallup		Puyallup		Puyallup	
Field or greenhouse	Field		Field No. 1		Field No. 2		Field		Field	
Soil type	Sandy Loam		Sandy Loam		Silt Loam		Sandy Loam		Sandy Loam	
Precipitation	0.79		0.85		1.85		0.83		--	
Soil moisture	Opt.		Opt.		Opt.		Dry		-----	
Number of seeds	100		100		100		100		100	
	Dosage	Stand	Dosage	Stand	Dosage	Stand	Dosage	Stand	Dosage	Stand
Untreated	----	12.6	-----	17.8	----	13.6	-----	41.4	-----	2.2
2% Ceresan			0.5	59.6**	0.5	30.2**			1.0	49.4**
2% Ceresan			1.0	78.4**	1.0	40.6**				
2% Ceresan			2.0	78.0**	2.0	44.6**				
Semesan			0.3	34.8*	0.3	27.4**				
Semesan soak			0.25	65.8**	0.25	31.0**				
Copper sulfate soak			2.0	28.2	2.0	20.2				
Red Cuprocide	2.0	52.8**	2.0	23.8	2.0	11.6				
Yellow Cuprocide			1.5	75.4**	1.5	40.6**			1.5	38.2**
Arasan			0.5	71.4**	0.5	33.0**	0.25	68.4	0.3	45.0**
Arasan			1.0	65.2**	1.0	39.2**	0.5	69.6		
Arasan			2.0	65.2**	2.0	35.2**	0.75	64.0		
Arasan							1.00	68.8		
Fermate			0.5	36.6*	0.5	24.2*	0.25	64.8		
Fermate			1.0	53.0**	1.0	33.0**	0.50	65.6		
Fermate							0.75	63.6		
Fermate			2.0	61.2**	2.0	37.2**	1.00	70.0		
Spergon	1.0	21.8	0.5	44.2**	0.5	18.6				
Spergon			1.0	59.6**	1.0	25.2*				
Spergon			2.0	65.0**	2.0	25.6*				
AAZ Special	2.0	32.4*	2.0	65.2**	2.0	33.0**			1.5	22.8**
DN-111	1.0		1.5	0.0†	1.5	0.0†			0.2	0.8
Dow Seed Prot. No. 6-B									0.75	1.8
Dow Seed Prot. No. 6-B									1.5	3.4
Zinc oxide, pure	2.0	33.8*								
Zinc oxide, tech.	2.0	31.0*					2.0	68.0		
Zinc hydroxide No. 1	2.0	52.0**								
Zinc hydroxide No. 2	2.0	34.2**								
Vasco 4	2.0	43.4**								
"F" obtained			5.57	17.8		11.4		1.91		30.6
"F" needed (5%)			2.25	1.73		1.73		2.15		2.36
Least mean diff. (5%)			17.2	14.7		9.3		N.S.		11.1
Least mean diff. (1%)			23.1	19.5		12.4				14.9

*Significantly better than the untreated set at the 5% level. †Significantly lower than the untreated set at the 5% level.
**Significantly better than the untreated set at the 1% level.

Table 14. SPINACH (Cont'd.)

Variety	Giant Nobel		Giant Nobel		Giant Nobel		Giant Nobel		Giant Nobel		Giant Nobel	
Date planted	March 29		March 28		April 12		May 18		May 15		May 24	
Year planted	1944		1944		1944		1944		1944		1944	
Location	Vancouver		Puyallup		Mt. Vernon		Vancouver		Puyallup		Mt. Vernon	
Field or greenhouse	Field		Field		Field		Field		Field		Field	
Soil type	Silt Loam		Sandy Loam		Sandy Loam		Silt Loam		Sandy Loam		Sandy Loam	
Precipitation	1.67		1.39		2.91		3.02		0.75		1.41	
Soil moisture	Opt.		Opt.		Wet		Opt.		Opt.		Opt.	
Number of seeds	200		200		200		200		200		200	
	Dosage	Stand	Dosage	Stand	Dosage	Stand	Dosage	Stand	Dosage	Stand	Dosage	Stand
Untreated	..	74.6	....	42.0	.	74.4	...	24.6	....	35.2	....	16.6
2% Ceresan	Max.	147.2**	Max.	131.6**	Max.	131.8**	Max.	60.6**	Max.	53.6*	Max.	63.2
Yellow Cuprocide	1.5	147.8**	1.5	139.8**	1.5	133.4**	1.5	90.6**	1.5	65.0**	1.5	50.6
Yellow Cuprocide	Max.	138.6**	Max.	130.2**	Max.	120.8**	Max.	72.0**	Max.	60.0**	Max.	54.2
Arasan	0.25	110.8*	0.25	128.2**	0.25	137.4**	0.25	54.4**	0.25	51.0*	0.25	46.6
Arasan	Max.	141.4**	Max.	140.4**	Max.	133.4**	Max.	63.2**	Max.	69.8**	Max.	56.4
Dow Seed Prot. No. 5	Max.	71.0	Max.	76.2**	Max.	129.4**	Max.	35.4	Max.	22.2	Max.	55.4
Spergon	1.0	73.8	1.0	73.2**	1.0	111.6**	1.0	23.8	1.0	23.4	1.0	53.0
Spergon	Max.	71.8	Max.	88.0**	Max.	138.2**	Max.	65.0**	Max.	32.6	Max.	53.2
Dow Seed Prot. No. 6-B	Max.	33.4†	Max.	33.4	Max.	87.0	Max.	28.6	Max.	34.4	Max.	35.4
"F" obtained	15.7		39.0		13.9		11.9		10.6		1.58	
"F" needed (5%)	2.15		2.15		2.15		2.15		2.15		2.15	
Least mean diff. (5%)	29.8		18.8		17.1		18.8		15.3		N.S.	
Least mean diff. (1%)	39.9		25.2		23.0		25.3		20.5			

*Significantly better than the untreated set at the 5% level.
**Significantly better than the untreated set at the 1% level.
†Significantly lower than the untreated set at the 5% level.

Table 14. SPINACH (Cont'd.)

Variety	Giant Nobel		Giant Nobel		Giant Nobel		Giant Nobel		Bloomsdale Savoy Dark Green	
Date planted	April 5		April 5		April 3		June 1		January 14	
Year planted	1944		1944		1945		1945		1946	
Location	Puyallup		Puyallup		Puyallup		Puyallup		Puyallup	
Field or greenhouse	Field		Field		Field		Field		Greenhouse	
Soil type	Sandy Loam		Sandy Loam		Sandy Loam		Sandy Loam		Mixture	
Precipitation	2.55		2.55		2.47		0.19		-----	
Soil moisture	Opt.		Opt.		Opt.		Opt.		Opt.	
Number of seeds	100		200		200		200		100	
	Dosage	Stand	Dosage	Stand	Dosage	Stand	Dosage	Stand	Dosage	Stand
Untreated	-----	2.8	-----	4.4	-----	10.0	-----	32.2	-----	28.8
Semesan					Max.	23.2	Max.	52.4*		
Yellow Cuprocide	1.5	8.2	1.5	33.8*	Max.	16.6	Max.	61.4**		
Arasan	0.25	19.0**	0.25	71.2**	Max.	26.0	Max.	44.8	Max.	67.2**
Phygon	1.0	20.6**	1.0	80.6**	Max.	26.2	Max.	56.8**	Max.	71.0**
Spergon	1.0	10.8*	1.0	61.4**	Max.	27.8	Max.	33.2	Max.	61.0**
Arasan & Semesan					Max.	29.2	Max.	62.0**		
Arasan & Spergon					Max.	25.2	Max.	60.0**	Max.	74.2**
Arasan & Yellow Cup.					Max.	26.2	Max.	66.8**		
Arasan & Sem. & Sper.					Max.	30.4	Max.	62.8**		
"F" obtained		11.6		11.5		2.02		4.13		8.82
"F" needed (5%)		3.01		3.01		2.15		2.15		3.01
Least mean diff. (5%)		6.6		27.5		N.S.		17.6		18.9
Least mean diff. (1%)		9.1		37.8				23.5		26.0

*Significantly better than the untreated set at the 5% level.
**Significantly better than the untreated set at the 1% level.

Table 15. SQUASH. Effect of Seed Treatments on Mean Stands.

Variety	Boston Brown Marrow		Boston Brown Marrow		Boston Brown Marrow		Golden Delicious		Golden Delicious	
Date planted	May 18		May 16		May 24		June 1		February 13	
Year planted	1944		1944		1944		1945		1946	
Location	Vancouver		Puyallup		Mt. Vernon		Puyallup		Puyallup	
Field or greenhouse	Field		Field		Field		Field		Greenhouse	
Soil type	Silt Loam		Sandy Loam		Sandy Loam		Sandy Loam		Mixture	
Precipitation	3.02		0.80		1.41		0.19		----	
Soil moisture	Opt.		Opt.		Opt.		Opt.		Opt.	
Number of seeds	200		200		200		200		100	
	Dosage	Stand	Dosage	Stand	Dosage	Stand	Dosage	Stand	Dosage	Stand
Untreated	-----	117.0	----	57.6	----	112.2	----	118.4	-----	12.6
Semesan	0.1	153.0**	0.1	70.6	0.1	161.8**	Max.	152.8**		
Semesan	Max.	176.2**	Max.	107.6**	Max.	172.2**				
Yellow Cuprocide	0.25	155.6**	0.25	97.4**	0.25	146.4**	Max.	157.8**		
Yellow Cuprocide	Max.	179.4**	Max.	150.2**	Max.	159.8**				
Arasan	0.1	114.4	0.1	32.4†	0.1	168.4**	Max.	144.8**	Max.	54.8**
Dow Seed Prot. No. 5	0.3	135.4**	0.3	90.2**	0.3	168.4**				
Phygon	0.25	177.2**	0.25	142.8**	0.25	173.0**	Max.	155.2**	Max.	71.6**
Spergon	0.25	120.2	0.25	80.6**	0.25	163.0**	Max.	138.6**	Max.	27.6**
Spergon	Max.	151.2**	Max.	126.4**	Max.	171.0**				
Arasan & Semesan							Max.	129.8		
Arasan & Spergon							Max.	146.2**	Max.	44.4**
Arasan & Yellow Cup.							Max.	143.8**		
Arasan & Sem. & Sper.							Max.	143.6**		
"F" obtained		34.6		96.1		24.7		6.7		71.4
"F" needed (5%)		2.15		2.15		2.15		2.15		3.01
Least mean diff. (5%)		12.3		11.0		10.6		13.2		8.2
Least mean diff. (1%)		16.5		14.7		14.3		17.7		11.3

†Significantly lower than the untreated set at the 5% level.
**Significantly better than the untreated set at the 1% level.

Table 16. TOMATOES. Effect of Seed Treatments on Mean Stands.

Variety	Break O'Day		Break O'Day		Pan American	
Date planted	April 23		April 23		May 25	
Year planted	1943		1943		1943	
Location	Puyallup		Puyallup		Puyallup	
Field or greenhouse	Greenhouse No. 1		Greenhouse No. 2		Field	
Soil type	Mixture		Mixture		Silt Loam	
Precipitation	-----		-----		0.52	
Moisture	Opt.		Opt.		Opt.	
Number of seeds	100		100		100	
	Dosage	Stand	Dosage	Stand	Dosage	Stand
Untreated	-----	43.8	-----	16.2	-----	34.0
2% Ceresan	0.5	63.6**	0.5	47.4**		
2% Ceresan	1.0	50.2	1.0	43.8**		
2% Ceresan	2.0	54.2	2.0	37.4**		
New Improved Ceresan soak	0.1	67.4**	0.1	51.6**	0.08	74.0**
Semesan	0.4	38.2	0.4	15.6		
Copper sulfate soak	2.0	55.2*	2.0	53.8**	1.5	74.8**
Red Cuprocide	2.0	43.6	2.0	17.8		
Yellow Cuprocide	1.5	65.6**	1.5	52.2**	1.5	66.2**
Arasan	0.5	58.2**	0.5	53.4**	0.3	73.6**
Arasan	1.0	62.4**	1.0	58.8**		
Arasan	2.0	72.2**	2.0	52.6**		
Fermate	0.5	56.2*	0.5	30.2*		
Fermate	1.0	58.4**	1.0	28.8*		
Fermate	2.0	51.8	2.0	46.4**		
Spergon	0.5	58.4**	0.5	51.0**	0.3	54.6*
Spergon	1.0	50.2	1.0	42.0**		
Spergon	2.0	61.2**	2.0	46.2**		
AAZ Special	2.0	67.6**	2.0	39.8**		
DN-111	1.5	38.8	1.5	14.6		
"F" obtained		6.36		10.6		8.99
"F" needed (5%)		1.73		1.73		2.87
Least mean diff. (5%)		10.8		12.5		15.8
Least mean diff. (1%)		14.3		16.6		21.6

*Significantly better than the untreated set at the 5% level.
**Significantly better than the untreated set at the 1% level.

Table 17. TURNIPS. Effect of Seed Treatments on Mean Stands.

Variety		Purple Top White Globe		Purple Top White Globe		Purple Top White Globe
Date planted		October 1		April 1		April 2
Year planted		1943		1944		1946
Location		Puyallup		Puyallup		Puyallup
Field or greenhouse		Greenhouse		Field		Greenhouse
Soil type		Mixture		Sandy Loam		Mixture
Precipitation		-----		2.47		-----
Soil moisture		Opt.		Dry		Opt.
Number of seeds		100		100		100
	Dosage	Stand	Dosage	Stand	Dosage	Stand
Untreated	-----	20.6	-----	5.2	-----	59.2
2% Ceresan	0.25	17.4	0.25	10.6		
2% Ceresan	0.75	21.0	0.75	10.2		
2% Ceresan	1.5	18.6	1.5	16.6*		
Semesan	0.4	24.4	0.4	19.6**		
Red Cuprocide	1.0	22.2	1.0	7.4		
Yellow Cuprocide	0.75	10.2	0.75	10.0		
Arasan	0.25	9.2	0.25	21.4**	Max.	74.8**
Arasan	0.75	17.4	0.75	20.8**		
Arasan	1.5	20.8	1.5	16.8*		
Fermate	0.25	14.0	0.25	12.6		
Fermate	0.75	12.0	0.75	21.4**		
Fermate	1.5	11.4	1.5	21.0**		
Dow Seed Prot. No. 5	1.0	11.4	1.0	27.2**		
Phygon					Max.	82.2**
Spergon	0.25	15.2	0.25	21.4**	Max.	74.4**
Spergon	0.75	17.0	0.75	16.6*		
Spergon	1.5	10.0	1.5	20.8**		
AAZ Special	2.0	21.0	2.0	17.8*		
Arasan & Spergon					Max.	83.0**
DN-111	1.0	0.4	1.0	0.0		
Dow Seed Prot. No. 6-B	1.0	9.0	1.0	9.8		
"F" obtained		1.69		3.37		19.6
"F" needed (5%)		1.73		1.73		3.0
Least mean diff. (5%)		N.S.		10.5		6.5
Least mean diff. (1%)				13.9		8.9

*Significantly better than the untreated set at the 5% level.
**Significantly better than the untreated set at the 1% level.

DISCUSSION AND CONCLUSIONS

The results definitely show that for most vegetables, seed treatment is good insurance in western Washington. Of nineteen crops tested, only kale and celery failed to give significant increases in plant stand after seed treatment.

Pathogens encountered in these tests were: **Fusarium spp.**; **Rhizoctonia spp.**; and various unidentified phycomycetes.

According to Walker's (12) terminology, the benefit from seed treatment in these experiments can be described as primarily that of seed protection, and secondarily that of seed disinfestation. It is unlikely that seed disinfection was a major contributing factor.

The results in general agree with those secured in other areas of the United States (7, 12). There are certain exceptions, however. Arasan, for instance, has been reported (7) to be injurious to lettuce seed, but such injury was not observed under western Washington conditions, even at the maximum concentration.

There was no appreciable difference in the results secured at Mount Vernon, Puyallup, and Vancouver in 1944, indicating that other results obtained at Puyallup would probably apply to most other parts of western Washington.

The mixtures of Arasan with other materials did not prove, in general, any more satisfactory than the materials used alone, and were occasionally less satisfactory. Leukel (7) summarized other research along this line and concluded: "The addition of some other materials may result in chemical reactions and the formation of new compounds that are ineffective as fungicides or are injurious to the seed."

Four summary tables of materials and crops are included in the next section. In Table 18 an attempt has been made to rate the value of the various materials for different crops based upon the foregoing tests. For such a rating each concentration of material used in a significant test was considered a trial. Such a rating may have its drawbacks but at least it partially removes the element of personal bias. Although several concentrations of many materials were used on the seeds, it is recognized that not all possible concentrations have been tried. Hence certain materials with an unfavorable rating in the summary table might have had a better rating if other concentrations had been tested.

Table 19 summarizes the results with materials used at the maximum concentration. Table 20 includes a list of crops, materials, and manufacturers' recommendations. Table 21 lists the various seed-treatment materials, their active ingredients, prices, and respective manufacturers.

These tests have demonstrated that seed treatment is definitely good insurance for the majority of vegetable crops in western Washington. Seed treatment easily repays its cost by controlling certain disease-producing fungi. This permits a decreased rate of seeding because of the increased emergence of treated seed, and also frequently prevents replanting and the consequent loss of time and labor.

Table 18. Summary of Results of Significant Tests with the Most Frequently Used Materials.[1]

	AAZ Special	Arasan	Ceresan 2%	Ceresan New Imp.	Copper sulfate soak	Cupro-cide Red	Cupro-cide Yellow	Dow DN-111	Dow Seed Pro-tectant 5	Dow Seed Pro-tectant 6B	Fermate	Phygon	Semesan	Spergon
Bean, Snap	*	***	*	*		*	*	*	**	****	*	**	****	****
Beet	**	****	****	**	**	*	***	*	*	****	***	**	*	*
Cabbage		**					*					*	**	**
Carrot	*	***	*		*	**	*	*			*	**	**	***
Cauliflower	**	****	***				**				****	*	**	****
Chard, Swiss	**	****	****	****	**	**	***	*	*	*	****	**	**	*
Corn	*	***	*			*	*	*	*		*	**	*	*
Cucumber	**	**	**			**	**	*		**	**	**	**	**
Lettuce	**	****	****		**	**	**				****	*	**	****
Lima Bean	*	****	****	**		*	*	*		**	****		**	****
Onion	**	***	*			*	*	*	*		*	*	*	*
Peas	**	****	****	**		**	****	*	****	****	****	****	****	****
Radish	**	****	****			*	*				****		**	****
Spinach	**	****	****		*	*	****	*	***	*	****	**	**	****
Squash		****					****		**			****	****	****
Tomato	**	****	****		**	*	**	*			****		*	****
Turnip	**	**	*			*	*	*	**	*	**	**	**	**

[1]Materials used on the following crops were not tested sufficiently to warrant inclusion in the above table.
Carrot—Semesan soak*
Cauliflower—Barbak C**, Calomel**, Metrox*, Phenothiazine*
Corn—Barbak C*, Semesan Jr.*, New Improved Semesan Jr.*
Cucumber—Semesan soak**
Lettuce—Phenothiazine**, Semesan soak**
Onion—Calomel dip*, Semesan soak*
Radish—Barbak C**, Calomel**, Phenothiazine*
Spinach—Semesan soak**, Vasco 4**, Zinc hydroxide No. 1**, Zinc hydroxide No. 2**, Zinc oxide pure**, Zinc oxide technical**
Tomato—New Improved Ceresan soak**

****Tested five or more times and significantly better than the check in more than half of the significant trials.
***Tested five or more times and significantly better than the check in more than one-third to one-half of the significant trials.
**Tested fewer than five times but significantly better than the check in at least one-half of the significant trials.
*Tested but less effective than the above.

Table 19. Summary of Results with Materials Used at Maximum Concentrations.

	Arasan	Calomel	Ceresan 2%	Cuprocide Yellow	Dow 5	Dow 6-B	Phygon	Semesan	Semesan Jr.	Spergon
Bean, Snap	*			—			*	*		*
Beet	*		*	*	*		*	*		*
Cabbage	*			*			*	*		*
Carrot	*						*			*
Cauliflower	*	*					*			*
Chard, Swiss	*		*	—	*	*	*			*
Corn	*			—			*	*	*	*
Cucumber	*			*			*	*		*
Lettuce	*						—			*
Onion	*				*			*		*
Peas	*			*			*	*		*
Radish		*								
Spinach	*		*	*	*	—	*	*		*
Squash	*			*			*	*		*
Turnip	*						*			*

—Reduced stand significantly below untreated seed in one or more significant tests.

*Did not reduce stands significantly below untreated seed in any significant test.

Table 20. Manufacturers' Recommenda

Material	Arasan* 1 lb.	Arasan* 100 lb.	Arasan** SF 100 lb.	Ceresan§ M 100 lb.	Ceresan§ 2% 100 lb.	Ceresan§ New Imp. 100 lb.	Cuprocide Yellow 1 lb.	Cuprocide Yellow 100 lb
Bean, Snap	⅛ tsp.	2 oz.	1.3 oz.				1/6 tsp.	3 oz
Beet	1⅛ "	8 "	5.3 "				1 "	24 "
Cabbage	⅔ "	4 "	2.7 "				1 "	24 "
Carrot	⅔ "	4 "	2.7 "				1 "	24 "
Cauliflower	⅔ "	4 "	2.7 "				1 "	24 "
Celery							1 "	24 "
Chard, Swiss	⅔ "	4 "	2.7 "				1 "	24 "
Corn, Sweet	⅛ "	2 "	1.3 "					
Cucumber	⅛ "	2 "	1.3 "				1/6 "	3 "
Kale	⅔ "	4 "	2.7 "				1 "	24 "
Lettuce	⅔ "	4 "	2.7 "				1 "	24 "
Lima Bean	⅛ "	2 "	1.3 "				1/4 "	4 "
Onion	⅔ "	4 "	2.7 "					
Pea	⅛ "	2 "	1.3 "	1.7 oz.	3.3 oz.	1.7 oz.	1/6 "	3 "
Radish	⅔ "	4 "	2.7 "				1 "	24 "
Spinach	⅔ "	4 "	2.7 "				1 "	24 "
Squash	⅛ "	2 "	1.3 "				1/6 "	3 "
Tomato	⅔ "	4 "	2.7 "				1 "	24 "
Turnip	⅔ "	4 "	2.7 "				1 "	24 "

*Can be used in excess without harm on all types of seeds listed, according to the manufacturer.

†Can be used in excess without harm on all types of seeds listed, except tomato, according to the manufacturer.

**Recommended for treating large amounts of seed with the slurry technique.

‡Recommended for use either with or without the slurry technique.

§Recommended only for treating large amounts of seed.

ow 9B Seed Protectant		Metrox		Phygon*, ‡ XL		Semesan†		Semesan Jr.		Spergon*	
lb.	100 lb.	1 lb.	100 lb.	1 lb.	100 lb.	1 lb.	100 lb.	1 lb.	100 lb.	1 lb.	100 lb.
		⅛ tsp.	4 oz.			¼ tsp.	3.4 oz.			⅓ tsp.	4 oz.
		½ "	32 "	1/3 tsp.	4 oz.	½ "	20.0 "				
						½ "	6.7 "			¾ "	8 "
		½ "	32 "			½ "	6.7 "			1 "	12 "
		⅛ "	4 "			½ "	6.7 "			¾ "	8 "
		½ "	32 "			¼ "	3.4 "				
		⅛ "	4 "	1/3 "	4 "	½ "	6.7 "				
tsp.	3 oz.	⅛ "	4 "	1/12 "	1 "	¼ "	3.4 "	¼ tsp.	2.7 oz.	⅓ "	3 "
		⅛ "	4 "			½ "	5.0 "			¾ "	8 "
						½ "	6.7 "			¾ "	8 "
		½ "	32 "	1/3 "	4 "	Soak only				1 "	12 "
		⅛ "	4 "							⅓ "	4 "
						¼ "	5.0 "				
		⅛ "	4 "	1/12 "	1 "	½ "	5.0 "			⅓ "	3 "
						½ "	6.7 "			¾ "	8 "
		½ "	32 "	1/3 "	4 "	½ "	5.0 "			1¼ "	14 "
		⅛ "	4 "			½ "	5.0 "			¾ "	8 "
		½ "	32 "	1/3 "	4 "	¼ "	3.4 "			1 "	12 "
						½ "	6.7 "			¾ "	8 "

Table 21. Materials used in Vegetable Seed Treatment Experiments, Western Washington, 1942-1946.

Material	Company	Address	Cost* (lb.)	Per cent active ingred.	Active ingredient
AAZ Special	Rohm & Haas Co.	Philadelphia, 5, Pa.	†	98%	zinc oxide
Arasan	E. I. du Pont de Nemours & Co.	Wilmington 98, Del.	1.15	50%	tetramethyl thiuramdisulfide
Arasan SF**	E. I. du Pont de Nemours & Co.	Wilmington 98, Del.	1.72	75%	tetramethyl thiuramdisulfide
Barbak C	American Cyanamid Co.	New York 20, N. Y.	†	8%	mercuric phenyl cyanamid plus 2.5% cadmium oxide
Calomel	Various		3.00	100%	mercurous chloride
Ceresan, 2%	E. I. du Pont de Nemours & Co.	Wilmington 98, Del.	0.58	2%	ethyl mercuric chloride
Ceresan, New Improved	E. I. du Pont de Nemours & Co.	Wilmington 98, Del.	0.61	5%	ethyl mercuric phosphate
Ceresan M**	E. I. du Pont de Nemours & Co.	Wilmington 98, Del.	0.69	7.7%	ethyl mercury p-toluene sulfonanilide
Copper sulfate	Various		0.15	100%	copper sulfate
Cuprocide, Red	Rohm & Haas Co.	Philadelphia 5, Pa.	†	83%	red cuprous oxide
Cuprocide, Yellow	Rohm & Haas Co.	Philadelphia 5, Pa.	0.50	90%	yellow cuprous oxide
Dow DN-111	Dow Chemical Co.	Midland, Mich.	†	20%	dicyclo-hexyl amine salt of dinitro ortho-cyclo-hexyl phenol
Dow Seed Protectant 5	Dow Chemical Co.	Midland, Mich.	†	100%	tetrachloroparabenzoquinone
Dow Seed Protectant 6B	Dow Chemical Co.	Midland, Mich.	†	65%	sodium 2, 4, 5-trichlorophenate
Dow Seed Protectant 9B**	Dow Chemical Co.	Midland, Mich.	0.52	50%	zinc—2, 4, 5-trichlorophenate
Fermate	E. I. du Pont de Nemours & Co.	Wilmington 98, Del.	0.75	70%	ferric dimethyldithiocarbamate
Metrox	Metals Refining Co.	Hammond, Ind.	1.00	95%	red cuprous oxide
Phenothiazine	Various		†	100%	Phenothiazine
Phygon	Naugatuck Chemical	Naugatuck, Conn.	†	83%	2, 3, dichlor-1, 4-naphthoquinone
Phygon XL**	Naugatuck Chemical	Naugatuck, Conn.	1.75	50%	2, 3, dichlor-1, 4-naphthoquinone
Semesan	E. I. du Pont de Nemours & Co.	Wilmington 98, Del.	2.20	30%	hydroxymercurichlorophenol
Semesan Jr.	E. I. du Pont de Nemours & Co.	Wilmington 98, Del.	0.50	1%	ethyl mercury phosphate
Semesan Jr., New Imp.	E. I. du Pont de Nemours & Co.	Wilmington 98, Del.	†	1%	ethyl mercury phosphate
Spergon	Naugatuck Chemical	Naugatuck, Conn.	1.78	98%	tetrachloroparabenzoquinone
Vasco 4	Virginia Smelting Co.	West Norfolk, Va.	†	58%	zinc oxide plus 10% zinc hydroxide

*Approximate retail price per lb. in 100-lb. lots, 1948.
†Not now being sold for seed treatment purposes.
**Not used in the experiments but included here for comparative purposes.

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